Memorandum to:
Brigadier General L. R. Groves
From:
Drs. Conant, Compton, and Urey
War Department
United States Engineer Office
Manhattan District
Oak Ridge Tennessee
October 30, 1943
Declassified June 5, 1974

1. Inclosed [sic] is a summary of the report written by Drs. James B. Conant, Chairman, A. H. Compton, and H. C. Urey, comprising a Subcommittee of the S-1 Executive Committee on the "Use of Radioactive Materials as a Military Weapon." It is recommended that a decision be obtained from competent authority authorizing additional work pertaining to the use of radioactive materials in order that this country may be ready to use such materials or be ready to defend itself against the use of such materials. The following program is recommended:

a. Immediate formation of a research and study group at the University of Chicago under supervision of the present Area Engineer. Assignment to this group of competent individuals now working on dust and liquid disseminating munitions and field testing of chemical warfare agents from the National Defense Research Council.

b. Assignment of a competent Chemical Warfare Service officer to the Chicago Area Engineer, who would become familiar with, and work on the problem under study by the University of Chicago. This officer should be experienced in the practical use of gas warfare.

c. The responsibility of the above organization would be:

(1) Develop radiation indicating instruments, expand present facilities of the Victoreen Company, and prepare a trial order for instruments with this company.

(2) Make theoretical studies pertaining to the methods, means and equipment for disseminating radioactive material as a weapon of warfare.

(3) Conduct field tests in isolated locations, such as Clinton Engineer Works or Sanford Engineer Works, using a non-radioactive tracer material.

(4) Prepare an instruction manual for the use of, or the defense against, radioactive weapons. This manual would be similar to that now used by the Chemical Warfare Service for gas warfare.

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(2) As a gas warfare instrument the material would be ground into particles of microscopic size to form dust and smoke and distributed by a ground-fired projectile, land vehicles, or aerial bombs. In this form it would be inhaled by personnel. The amount necessary to cause death to a person

inhaling the material is extremely small. It has been estimated that one millionth of a gram accumulating in a person's body would be fatal. There are no known methods of treatment for such a casualty

Two factors appear to increase the effectiveness of radioactive dust or smoke as a weapon. These are: (1) It cannot be detected by the senses; (2) It can be distributed in a dust or smoke form so finely powdered that it will permeate a standard gas mask filter in quantities large enough to be extremely damaging. An off-setting factor in its effectiveness as a weapon is that in a dust or smoke form the material is so finely pulverized that it takes on the characteristic of a quickly dissipating gas and is therefore subject to all the factors (such as wind) working against maintenance of high concentrations for more than a few minutes over a given area.

c. Possible Use by the Enemy.

It is felt that radioactive warfare can be used by the Germans for the following purposes:

(1) To make evacuated areas uninhabitable.

(2) To contaminate small critical areas such as rail-road yards and airports.

(3) As a radioactive poison gas to create casualties among troops.

(4) Against large cities, to promote panic, and create causalities among civilian populations.

For use in cities, it is estimated that concentrations would have to be extremely high to offset the shielding effect of buildings

Doctors Compton and Urey, two members of the Committee, felt that radioactive material may be used by the Germans against United Nations in the autumn of 1943. Dr. Conant apparently does not concur in this opinion.

d. Possible Use by the United States.

It is the recommendation of this Subcommittee that if military authorities feel that the United States should be ready to use radioactive weapons in case the enemy started it first, studies on the subject should be started immediately.

The possible military uses of radioactive materials follow:

(1) As a Terrain Contaminant. To be used in this manner, the radioactive materials would be spread on the ground either from the air or from the ground if in enemy controlled territory. In order to deny terrain to either side except at the expense of exposing personnel to harmful radiations

Estimates indicate that these materials could be produced by the Germans in such quantities that each four days two square miles of terrain could be contaminated to an average intensity of radiation three feet above ground level of one hundred roentgens per day. One day's exposure (100 roentgens to the whole body) would result in temporary incapacitation, a lesser period of exposure in incapacitation to a lesser degree and one week's exposure in death. Effects on a person would probably not be immediate, but would be delayed for days or perhaps weeks depending upon the amounts of exposure. Exposure to five to ten times the above described concentration would be incapacitating within one to two days and lethal two to five days later.

Areas so contaminated by radioactive material would be dangerous until the slow natural decay of the material took place, which would take weeks and even months. On a hard smooth surface some decontamination could be accomplished by flushing with water, but for average terrain no decontaminating methods are known. No effective protective clothing for personnel seems possible of development.

(2) As a Gas Warfare Instrument. The material would be ground into particles of microscopic size and would be distributed in the form of a dust or smoke or dissolved in liquid, by ground-fired projectiles, land vehicles, airplanes, or aerial bombs. In this form, it would be inhaled by personnel. The amounts necessary to cause death to a person inhaling the material is extremely small. An infintesimal amount accumulating in a person's body would be fatal in a few day to weeks depending upon the amount absorbed and its radioactivity. There are no known effective methods of treatment for such a casualty.

Areas so contaminated by radioactive dusts and smokes, would be dangerous as long as a high enough concentration of material could be maintained. In these forms, the materials take on the characteristics of a quickly dissipating gas and it is improbable that heavy concentrations could be maintained for more than a few minutes time over a given area. However, they can be stirred up as a fine dust from the terrain by winds, movement of vehicles or troops, etc. , and would remain a potential hazard for a long time.

These materials may also be so disposed as to be taken into the body by ingestion instead of inhalation.. Reservoirs or wells would be contaminated or food poisoned with an effect similar to that resulting from inhalation of dust or smoke. Four days production could contaminate a million gallons of water to an extent that a quart drunk in one day would probably result in complete incapacitation or death in about a month's time.

B. From Internal Sources

RESPIRATORY TRACT: Dr. Wollan has estimated that an accumulation of 10^{-3} curies of high-energy beta-ray active material would produce an exposure of about 100 r/day to the lungs. Unfortunately, there is no experimental data bearing directly upon the deposition of f products nor on the action of the beta-rays on the bronchial and alveolar surfaces.

Particles larger than 1µ[micron]in size are likely to be deposited in nose, trachea or bronchi and then be brought up with mucus on the walls at the rate of 1/2 - 1 cm/min. Particles smaller than 1µ [micron] are more likely to be deposited in the alveoli where they will either remain indefinitely or be absorbed into the lymphatics or blood. The probability of the deposition of dust particles

anywhere in the respiratory tract depends upon respiratory rate, particle size, chemical and physical nature, and the concentration in the atmosphere. Hence the probability of f products causing lung damage depends on all of these factors.

While only fragmentary information is available, it is felt that the injury would be manifest as bronchial irritation coming on in from a few hours to a few days, depending on the dose. It would not be immediately incapacitating except with doses in the neighborhood of 400 or more r [roentgens] per day. The most serious effect would be permanent long damage appearing months later from the persistent irradiation of retained particles, even at low daily rates.

It would seem that chemical gases could accomplish more and do it more quickly so far as the skin surfaces and lungs are concerned. The beta emitters would have more permanent effects -- starting months after exposure.

GASTRO-INTESTINAL TRACT: Beta emitting f [fission] products could get into the gastro-intestinal tract from polluted water, or food, or air. From the air, they would get onto the mucus of the nose, throat, bronchi, etc., and be swallowed. The effects would be local irritation just as in the bronchi and exposures of the same amount would be required. The stomach, caecum, and rectum, where contents remain for longer periods than elsewhere would be most likely to be affected. It is conceivable that ulcers and perforations of the gut followed by death could be produced, even without any general effects from the radiation.

BLOOD STREAM AND TISSUES: Beta and gamma emitting fission products may be absorbed from the lungs or G-I tract into the blood and so distributed throughout the body.